RoboBUG: A Game-Based Approach to Learning Debugging Techniques

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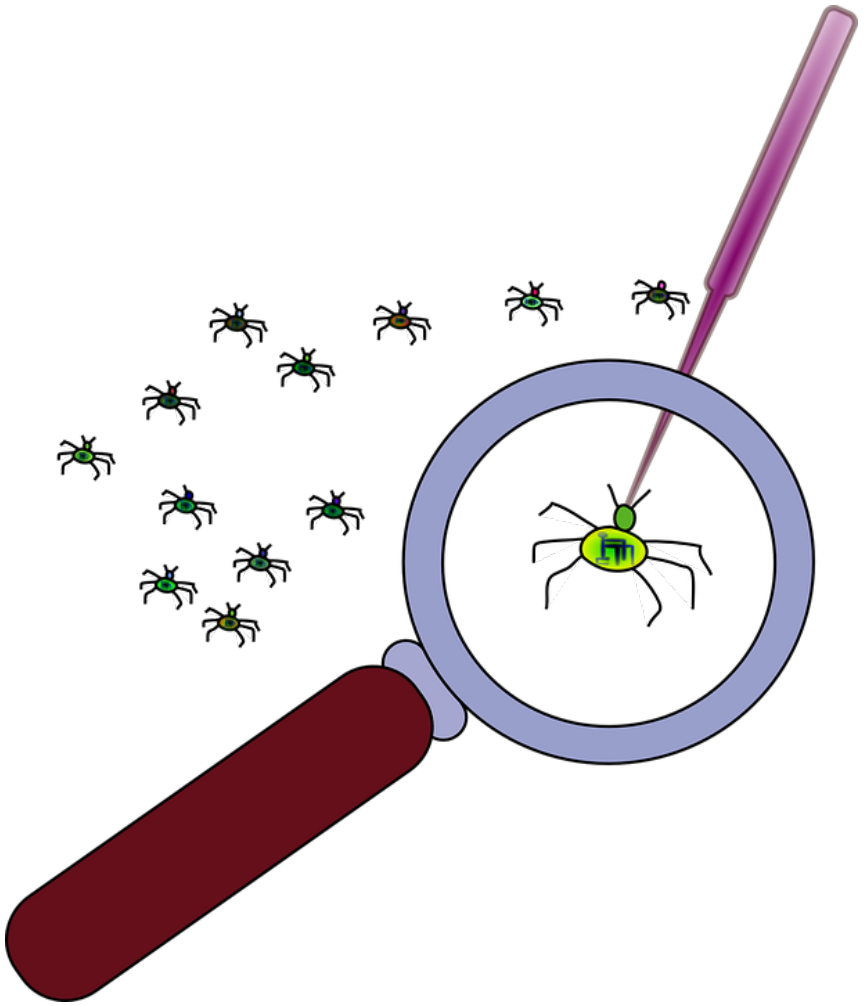
How Important is Debugging?



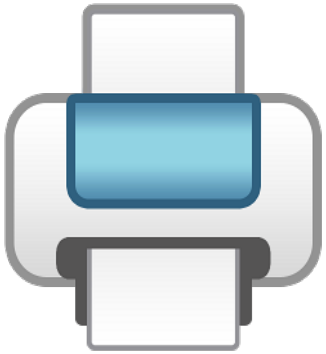
- **50%** of development time spent on debugging
- **100%** of projects use debugging
- **All levels** of skill need to debug

Debugging is Difficult!

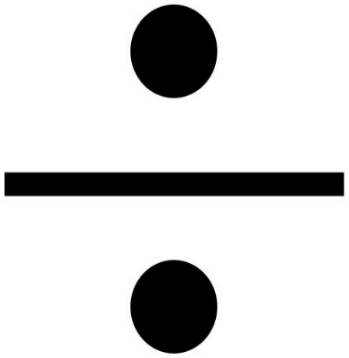
- Especially for **novices**
- Not discussed in class
- Time-consuming
- Very **frustrating**

Debugging Techniques for Novices

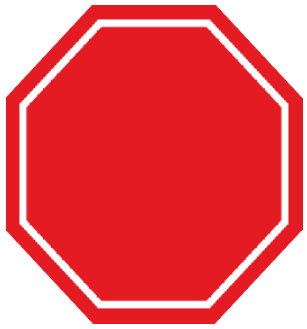
Code Tracing



Print Statements



Divide & Conquer

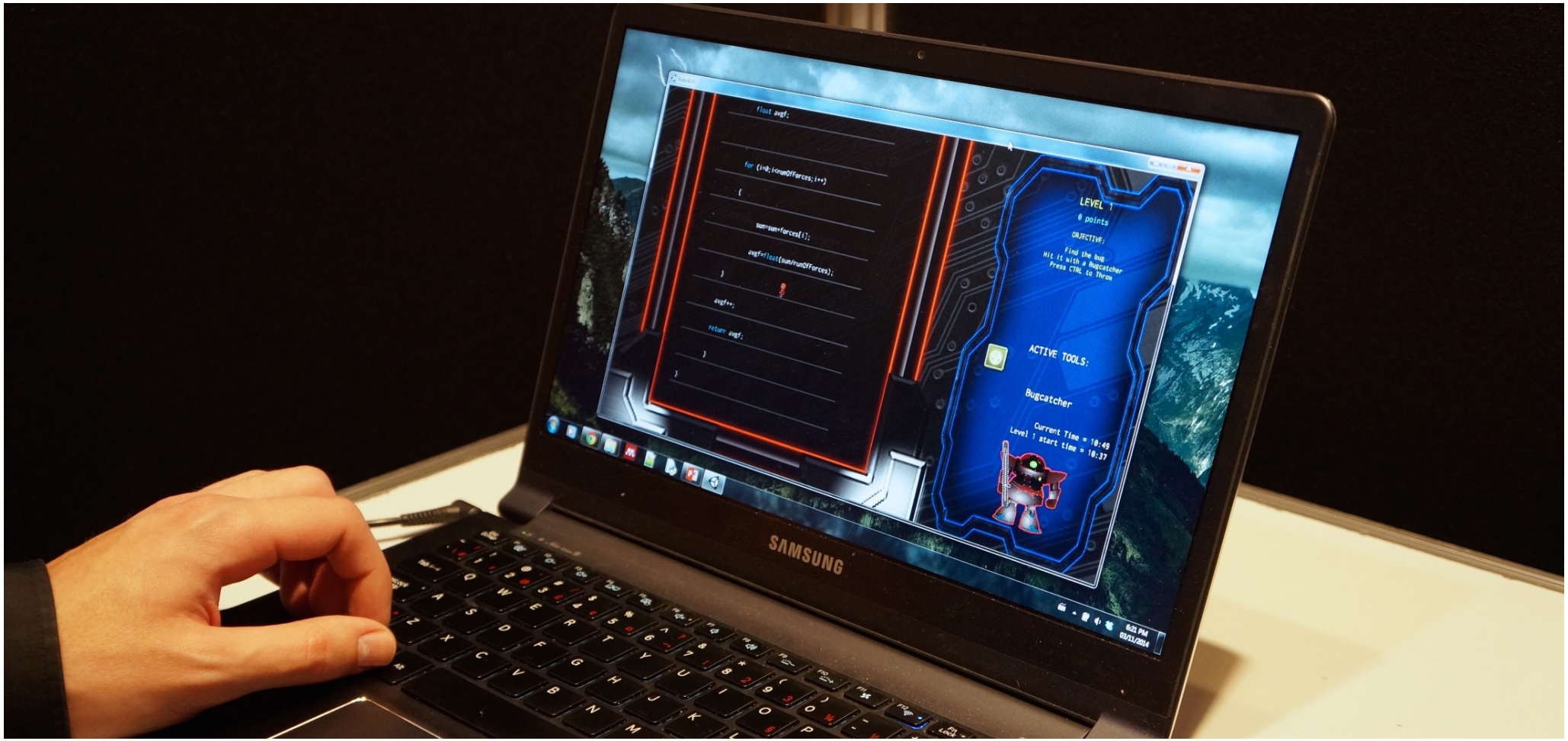


Breakpoints

RoboBUG

- Players take the role of a programmer trying to repair their ‘Mech Suit’
- Controlling a robotic avatar, the player moves through C++ source code in a hunt for bugs

Demonstration



https://github.com/sqrlab/robobug

RoboBUG: A Serious Game for Learning Debugging

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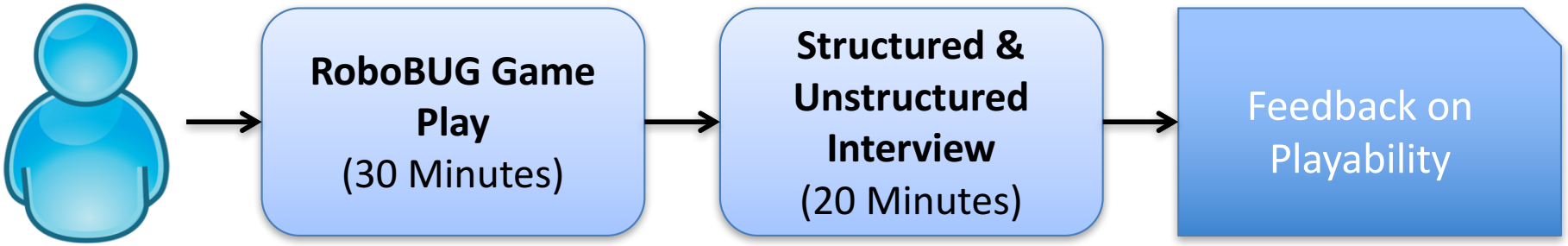
RoboBUG Features

```
<level>
<description>You must use the BUGCATCHER Tool to catch bugs.
Look at the code. Which line is incorrect? Go to that line.
Press CTRL to throw the BUGCATCHER at the bug!</description>
<nextlevel>level1a.xml</nextlevel>
<introtext>Finding bugs requires CODE TRACING.
This requires you to manually read the code
and try to understand it to find the bug.</introtext>
<endtext>You got it!
You can now use BUGCATCHERS!</endtext>
<time>1000</time>
<tools>
<enabled count="999">0</enabled>
</tools>
<code>int Square(int x){
    //calculate the square of x
    <bug size="1" col="13">x = x + 598439;</bug>
    return x * x;
}
</code>
</level>
```

- Simple XML-based level creation
- Allows any language
- Logs player progress

Evaluation - Playability

- Is the RoboBUG game playable by undergraduate students?



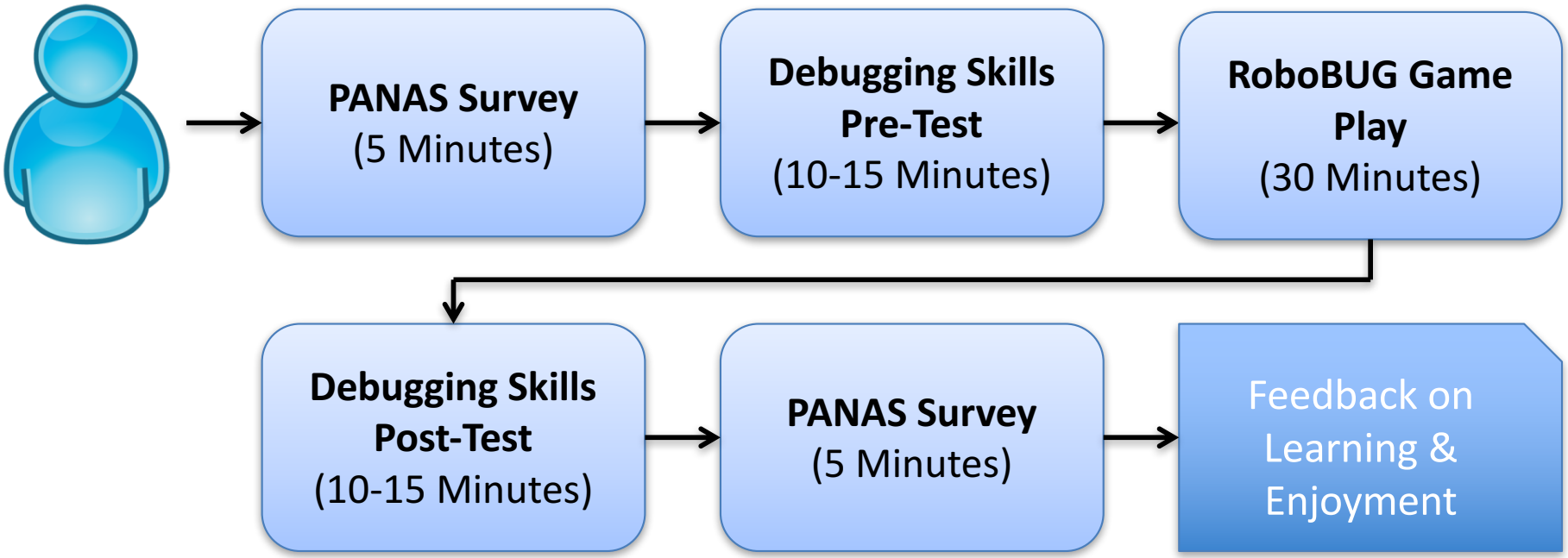
Results – Playability Interview

Overall results were positive

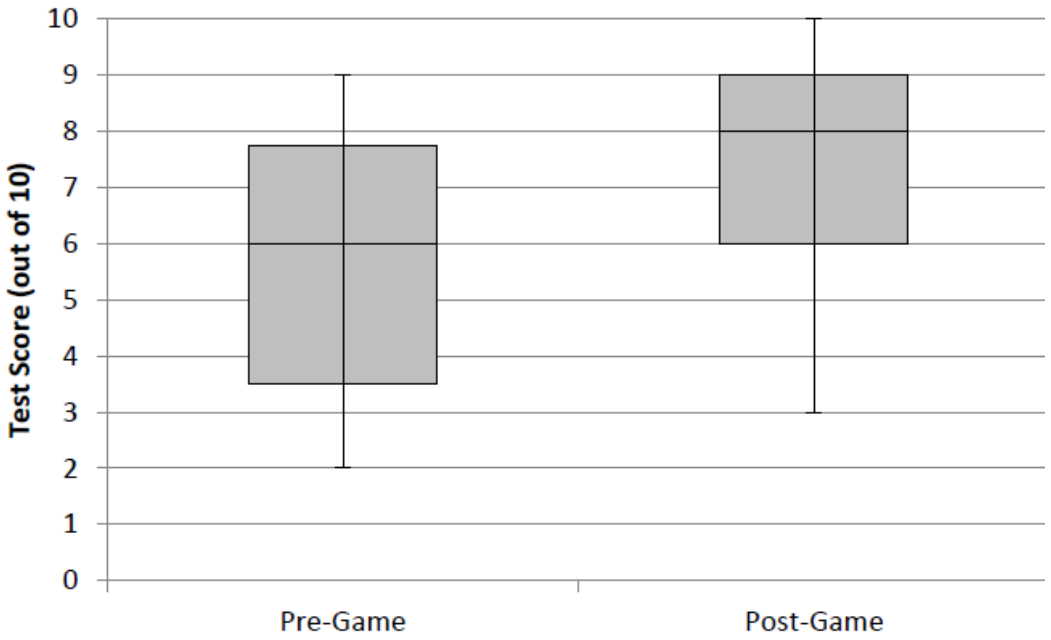
- *"[I **enjoyed**] trying to test my skills with how good I am with debugging."*
- *"It's a **great tool**, that's what I can say."*
- *"The way that the divide and conquer was set up was **pretty cool**."*
- *"The inclusion of breakpoints was kind of **innovative**."*
- *"[The warper tool] was **interesting** because I thought all of the code would be in one class."*
- *"I think that the warper/commenting, being able to zip between different segments of code was **really good**."*

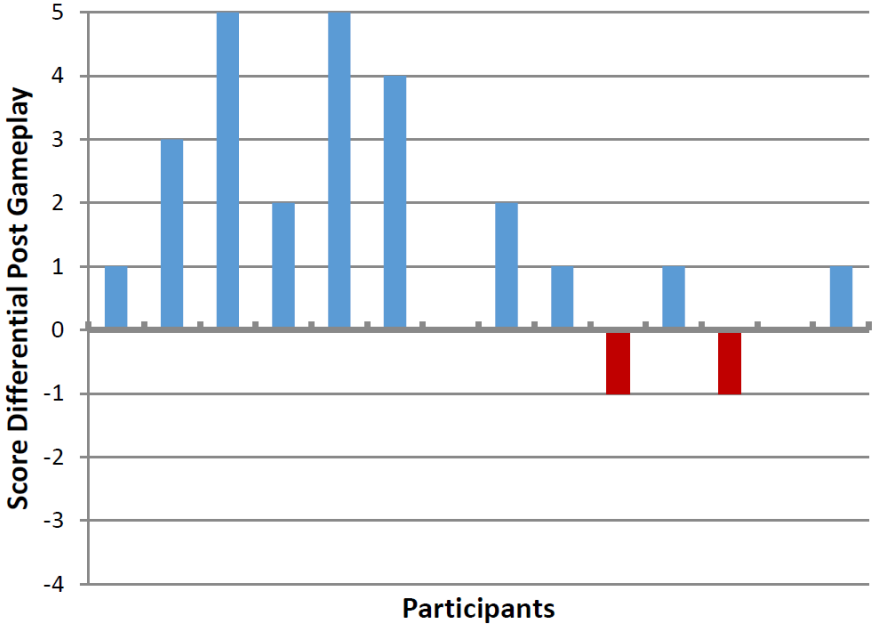
Evaluation – Learning & Enjoyment

- Does RoboBUG improve a student's understanding of debugging techniques?
- Do students enjoy playing the RoboBUG game?



Results – Learning





(sorted from lowest to highest pre-test score)

Overall test scores improved

Less skilled participants showed greater improvements

Results – Enjoyment

Positive Keyword	Average Change	Negative Keyword	Average Change
Interested	-0.64	Anxious	-0.21
Enthusiastic	-0.64	Nervous	-0.14
Alert	-0.50	Guilty	-0.07
Excited	-0.36	Stressed	-0.07
Determined	-0.36	Depressed	-0.07
Attentive	-0.36	Scared	0.00
Proud	-0.14	Distressed	0.07
Inspired	-0.14	Hostile	0.07
Happy	-0.07	Jittery	0.29
Confident	0.00	Afraid	0.29
Active	0.07	Irritable	0.36
Strong	0.14	Upset	0.43
		Ashamed	0.43

No statistically significant difference on mood before and after gameplay

Future Work

- Additional **experimentation** to address limitations
  - Small sample size, short game length
  - Longitudinal benefits of RoboBUG
- Improved game **design**
  - UI, accessibility
- Wider **application** of CS game-based learning

Conclusions

- RoboBUG helps students achieve **debugging learning outcomes**
- RoboBUG is particularly effective at aiding students **not initially skilled** at debugging
- Improving the **enjoyment** of debugging remains an open problem

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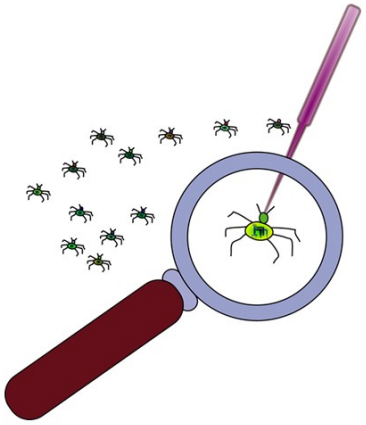

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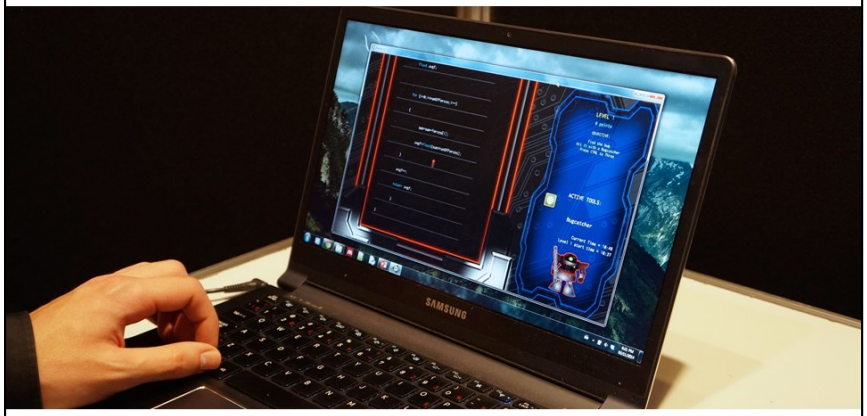

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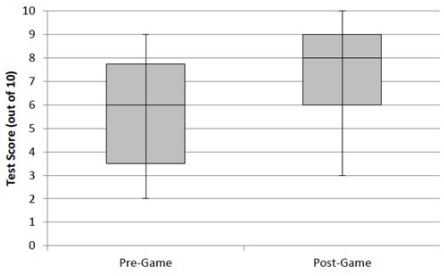

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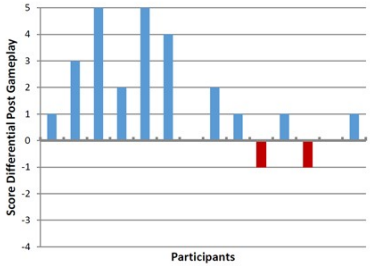

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